With the Compliments of the Secretary of the Planters' Association of Ceylon.

with J B Carruthers's thanks & compliments

PLANTERS' ASSOCIATION OF CEYLON,

KANDY.

SECOND REPORT

ON

CACAO DISEASE

BY

J. B. CARRUTHERS, F.L.S.

COLOMBO:
PRINTED AT THE "TIMES OF CEYLON" STEAM PRESS.

1898.

PLANTERS' ASSOCIATION OF CEYLON,

KANDY.

SECOND REPORT

ON

CACAO DISEASE

BY

J. B. CARRUTHERS, F.L.S.

K. write Int. Dept.

COLOMBO:
PRINTED AT THE "TIMES OF CEYLON" STEAM PRESS.

1898.

PLANTERS' ASSOCIATION OF CEYLON.

SECOND REPORT

ON

CACAO DISEASE

IN CEYLON PLANTERS' [illegible]

SECOND REPORT ON CACAO DISEASE,

BY

J. B. CARRUTHERS, F.L.S.

In preparing a report on the cacao canker, it is difficult to select from the facts observed those which teach more clearly the lessons which it is important for cultivators to know, and not to burden the pamphlet with an amount of detail which, in some cases, sheds only a small amount of light on the subject.

I shall endeavour to make this account as popular as is consistent with accuracy, so that cultivators having practical and not scientific knowledge of cacao, may not lose any information it may contain.

When my investigations had been in progress for three months, I submitted an interim report, and in that described the methods by which I endeavoured to discover the nature and life-history of the disease or diseases attacking cacao, so that in this report, for the sake of brevity, I need only give the facts arrived at. Any who are interested in the processes by which these facts were gained, can, by reading the interim report, trace the method of investigation.

Happily, the statements previously recorded need in no case to be corrected, and the further information gained as to the life-history of the canker fungus, shows that the deductions based on these facts were trustworthy.

In the first place, I propose to describe the disease as it appears to the planter and the effect produced on the tree and its crop; next giving the life-history of the fungus causing it—on the cacao,—the means by which it spreads, and the conditions favouring it and its increase; and then describe the treatment which, after a series of varied experiments, gave the best curative results—and seem to a great extent successful; as well as the preventive means which should ensure that all plantations at present not attacked by the disease may be kept free from it.

It may be well to state here at once that, in my opinion, the result of the investigation has been to show that, though no doubt the presence of the canker will mean an extra expense in cultivation (thought not a serious one), it in no way threatens the profitable cultivation of cacao, and we may hope

that it will lead to an improvement in methods and a consequent increase of yield. Of course, an unknown enemy is always more alarming, but now that we have a knowledge of the nature of the evil, it loses, to a great extent, its tenor. The appearance of cacao, both of the Forastero and Criollo varieties, is well known to all cultivators, and the number of deaths due to drought and the attack of insects and fungi was, in Ceylon, extremely small, until about five or six years ago, when some planters noticed a great increase in the number of casual deaths; and this increase went on until it became a most serious matter, and seemed to endanger the profitable cultivation of cacao in Ceylon. It was not until the disease had done damage to a very considerable extent that scientific help was asked for, and, no doubt, the loss might have been spared in great measure if investigations had been made soon after the disease appeared, and not delayed until it had spread over such a large area. This, however, is nearly always the history of such plant diseases, and will be so until the experience has been dearly bought, that in plant-life just as in human sanitation, sporadic diseases should be carefully observed and measures taken to prevent them becoming epidemic. It is a very self-evident fact, but one that requires reiteration, that the usual method of cultivation, viz., the unnatural crowding together of one species, favours the rapid spread of diseases due to foreign organisms, and therefore make prompt measures the more necessary.

It is not very easy to estimate the amount of damage done, as in many cases, by supplying new plants, the estates have partially recovered; but there is no doubt that a serious monetary loss has been incurred both by decrease of the crop and expense of supplying up diseased estates. I have visited some 40 estates in all districts of Ceylon, and, though I am glad to say some places have, for reasons afterwards mentioned, not been attacked at all, yet in other cases some estates have been practically wiped out by the canker. That the canker is confined to the stem and branches of the cacao and does not affect the roots is clearly shown by the following facts:—1stly, when suckers are formed from the stumps of diseased trees cut down, they are quite healthy, and show no sign of disease. 2ndly, new cacao plants put in a few inches from the diseased trees grow vigorously and without disease, though the roots of the two plants must be touching in many places; and 3rdly, the examination of many roots of cankered trees showed no trace of the fungus, and all attempts to induce it in roots by inoculation failed.

The first sign of disease apparent to the naked eye is a darkening of a portion of the cortex of the tree caused by an

excess of moisture immediately below it, and this is usually not accompanied by any "shuck" appearance in the tree. In some cases the cortex has been pierced by insects at the moist places, and this causes an exudation at each puncture of a drop of claret-coloured fluid which, when it runs down the cortex and dries, gives the tree a rusty appearance over the dark spot. If the cortex be shaved off, the tissue will be found to be soft and of a darkish claret or neutral colour and so full of moisture that small drops exude from all over the cut surface, which feels soapy and moist to the touch. This condition is due to the presence of the mycelium or roots of the fungus in the bark tissues in large quantity. The tree, to replace the damage done to its tissues, sends an abnormal amount of sap to the diseased spot. The existence of such a moist area in the bark means that the disease has been for some time—a varying time: in some cases weeks, in others months—in the tree, as it is not until the fungus has got a good hold of the tissues that such an effect is produced.

This characteristic discoloration of the bark tissues is variable. In cases where the mycelium is only present in small quantity, the colour is very little different from that of the healthy bark, and in many cases it is impossible for the eye to detect it. When the mycelium exists to any extent, a neutral tint is produced, and this is gradually intensified until, when the fungus has completely permeated the bark cells, the discoloration is most marked. If this infected area is closely observed in the course of time—and as I will shortly point out this time varies considerably—a number of whitish pustules will be seen on the surface of the cortex (Fig. 1). The pustules are of just about the size of a pin's head, and increase to the size, sometimes, of a large pea; and, as a rule, they become pink later. These are the reproductive bodies of the fungus, and consist of a mass of spores (spores may be, for all practicable purposes, considered as the seeds of the fungus). It is by means of these spores that the canker spreads from tree to tree. If we examine the tissues of the bark at a diseased spot microscopically, we shall find all the cells, from the cortex to the old wood, permeated by thin strands (Fig. 2)—almost colourless. The mycelium of the fungus and these are more massed at the points where they have forced their way through the cortex and produced their spore pustules. The cortex of parts of a tree some eight or ten years old, is, as a rule, slightly cracked in places, and it is at these weaker parts that the spore masses are found protruding. As was mentioned above, these spore-pustules change from a dirty white to a pink colour. In the white stage—which is the first—the spores formed are extremely small, oval or egg-shaped, and formed in chains. In order to

afford some notion of the size of these spores—at a rough calculation, about five million, one layer thick, would be required to cover the surface of a ten cent piece. Later on from behind, second and differently-shaped spores are formed, which are much larger—about six times the size of the primary spores—and are in the form of a crescent or bent cylinder and septate, *i. e.*, having a number of transverse partitions, usually eight.

If one of the small spores be placed in a suitable medium and kept moist, in the course of from 12 to 15 hours, they begin to germinate, pushing out a tube, which, as it grows, branches frequently, often coalescing with neighbouring branches, and in about 50 hours producing spores like those from which they originated. Unfortunately, though this method of cultivating and observing the growth of spores is of the greatest interest, yet it is of less value than observing the growth of the fungus in the living cacao stem (and this is unfortunately impossible) because the rapidity and vigour of growth vary according to the media employed. Thus, in a water or gelatine culture the spore, in germinating, does not behave as it does in the tissue of the cacao bark, where, of course, the resistance to growth is greater and the nutritive material different.

The method of growth of the secondary spores is very similar, except that a number of tubes are sent out from the spore, even sometimes one from each of the eight chambers into which the spores are divided. As a rule, the growth is not nearly so rapid.

Both these forms of spores are technically called "gonidia." The fungus, however, in addition to producing the simple gonidia spores, has a third and more complex fruit, which will be described later. These fruits are called "sporangia."

In order to trace the further progress of the disease, if we leave the diseased spots still longer and allow them to spread until they either completely cover the bark or else go completely round the tree, and thus "ring" it and prevent any nutrition passing up to the branches above, then the tree dies—the time taken to kill the tree depends on a number of very varying circumstances and conditions, viz :—the quantity of mycelium in the affected tissues ; the vigour of the remaining healthy portions of the tree ; the amount of moisture in the soil capable of being used by the roots ; and the damage being done to the tree by other enemies, borers, &c. Clearly, therefore, it is not possible to give any exact data as to the time taken by the fungus to kill the tree, and in my inoculation experiments (described in my interim report) there was the

greatest diversity in the rate of growth even in trees apparently equally vigorous and under exactly similar conditions. In one case, after the tree was inoculated and a diseased spot produced, the area of the diseased portion increased only just a noticeable distance (about $\frac{1}{4}$ inch) every day; in the next tree experimented on, the spot increased its area very rapidly, and in about ten days covered a space more than two feet long, and almost round the tree. In these cases, however, the difference in time is explicable in other ways also. In the one case, a great many of the spores used in inoculating the part may have germinated, and in the other few, and also the condition of the cells, more or less damaged by the cut made for the inoculation, and the quantity of sap they possessed would naturally influence the growth of the mycelium.

When the tree is being killed by the canker fungus, it exhibits all the symptoms of death from want of nutrition, *i. e.*, the browning of the leaves and fruit, and the gradual drying-up of the bark of branch and stem. Before the bark has quite dried, the third and more perfect reproductive bodies are produced. They are easily recognised with the naked eye, as small crimson spherical bodies, generally in clusters (Fig. 3). They are individually not so large as a pin's head, but a number together are easily detected by their size as well as their colour. The best place to look for these is on the cortex of old trees and branches cut down because dead.

These spherical bodies are the coverings of the third form of spores, and contain a number of sack-like transparent bodies, which, in their turn, contain each eight spores. These spores are larger than the primary gonidia spores and are uniseptate, *i. e.*, having one division (Fig. 4).

A very large and important group of fungi are characterised by the possession of these spores—ascospores—so called from their being enclosed in asci or the sack-like bodies described above, and in many of the fungi in the asci group—the formation of gonidia spores precedes the production of the spherical sporangia enclosing the asci.

We have here the complete history of the canker fungus, which passes all its life on the cacao and produces all its three forms of spores there. It grows in the bark of the stem and branches, and not in the root, often spreading down below the surface of the ground to the root, but never invading it and never passing into the leaves.

With regard to the relation of the two varieties of cacao grown in Ceylon, the Forastero with the white or green pod, and the Criollo, or Red, with the red fruit, the canker—both

experiments and observations point to the fact that the Forastero is much less attacked by the canker than the Criollo. In fact the Forastero seems more robust in resisting all the enemies of cacao. I have seen a fine Forastero tree towering many feet above its neighbours, all of which were Criollo, and were damaged by the wind. There can be no doubt that the Forastero can be brought to a higher state of cultivation here than the red or Criollo, and all supplies should be of the hardier variety.

With regard to climatic conditions affecting the canker, the matter is one on which, to a certain extent, a misunderstanding exists. There is a prevalent idea in the case of the cacao canker, as well as in other specific diseases, that an unhealthy, and not vigorous, tree is more *liable* to the disease than one full of vigour ; this is misleading. There is no proof whatever that such is the case, and it might almost be said that the evidence points more to the infection of healthy trees than unhealthy ones, but it must always be borne in mind that the healthy trees when attacked fight better against the disease, and have more chance to overcome it, whereas, in the case of weaker plants, they succumb sooner. *No special pre-disposition of the tree is necessary for the attack of the fungus* ; the only conditions needful are moisture and heat. The latter we have always in sufficience in this country, and, therefore, it is the dampness as the condition which varies, and which is prejudicial to the tree when considering attacks of canker. The easiest way to understand these conditions is to remember that for all practical purposes the conditions necessary for the germination of a seed are the conditions necessary for the germination of the spores of fungi. In the case of the canker the spores may be blown upon a tree during a dry period, and will, after being exposed to dry air for some time (and of course much more quickly if in direct sunlight), lose their power of germination. If, however, these spores alight on the cortex of a tree, when the air is charged with moisture, and when the stem itself is damp, it is almost certain to penetrate and infect the tree. With regard to the entrance of the germinating tube of the spore into the bark tissues, there is here a rather difficult point to decide whether the young mycelium can force its way through hitherto unbroken cortex, or whether it must find an opening caused by a natural crack, an insect puncture, or a casual injury. My experience on this subject leads me to think that in the case of young trees or the young parts of old trees, the mycelium can penetrate, but in the case of thicker cortex on old trees there must be some opening by which an entrance can be effected.

In this connection reference may be made to a belief which is current that the period of healthy life of the cacao

tree is limited to about 15 years. A visit to some of the older plantations in Ceylon, twenty years and older, many of which are bearing now more per tree than ever before, would dispel this idea, and there seems to be nothing to contradict the belief that if the cacao tree is properly treated and has room to grow, it should yield good crops for twice twenty years, and probably longer. In many cases where the borers are allowed to ravage the tree without hindrance, the life of the tree is short, and in most cases where deaths are seen at so early an age as that mentioned above, it is due to this or other external causes.

The most important part of this report to the practical planter, however, is the portion dealing with preventive and curative measures.

The conditions necessary for the growth and spread of fungi have been described above, and these conditions, must, as far as possible, be kept away ; but there are other enemies to consider in growing good cacao besides the canker. *Helopeltis* is in many cases a very serious evil, and experience has shown that in many cases, where the shade is taken away, the result is such an increase in the number of the *Helopeltis* that the cacao is seriously damaged. Wind is also very injurious to cacao in many places, and make it impossible to grow it without protecting shade trees. Much depends on the situation with both the enemies. There is cacao in Ceylon growing in the most excellent vigour (and this is one of the hottest districts) without a vestige of shade, and where the *Helopeltis* does not do much damage there is no doubt that the cacao is much safer from danger of being attacked by canker when grown absolutely in the open. However, taking the *Helopeltis* as an enemy that must be reckoned with, it is important that the shade employed to keep away this pest should not be too dense, to prevent the sun getting through, and keeping the air and the stems of the trees dry. A light flickering shade is in most cases enough to keep away *Helopeltis* in great quantity, and such a shade at some distance above the cacao trees does not keep the undergrowth at all damp. For wind, of course, belts are the most efficacious, and not numerous trees growing among the cacao.

In some cases the cacao trees are placed so near together (I have seen cacao 12–15 years old six feet apart) with the branches overlapping each other that, although the overhead shade may be light, the cacao itself is keeping the atmosphere around the stems damp, and such conditions, apart from the cramping effects on the trees, are most favorable to the increase of the canker fungus. All planters recognise the importance of good drainage in keeping their cacao healthy, and this is of course also important in relation to reducing the amount of moisture in the air.

The preventive measures, therefore, are to keep the cacao under conditions which do not favour the germination of the spores. With regard to application of fungicides as preventive means, the best of these are those having sulphate of copper (blue stone) as their basis, Bordeaux mixture, &c. Sulphate of copper is the most powerful fungicide which has comparatively little effect on the external tissues of the plant we know of. Experiments show that spores will not germinate in a solution of copper sulphate containing only one part in 500,000. If a thin coating of this substance could be kept on stem and branch, no doubt this would effectually prevent the germination of any of the spores on the trees, but the time when the spores germinate is the time when there is continual rain, and during these periods it is practically impossible to keep the copper sulphate on the trees, every shower washing it away. Though I am a firm believer in the efficacy of copper sulphate as a preventive to fungi, yet it seems to me that in the case of cacao cultivation it is not practicable.

Remedial measures are, in plant pathology, peculiarly hard to prescribe, and my time has been mainly occupied, since I have become acquainted with the nature of the disease, with this most important question.

In all cases of canker of bark, whether fruit or timber trees, the remedy has for many years been surgical, viz., to cut out the diseased tissue; and there is no doubt that in the case of the cacao canker, this is the safest and most effectual remedy. I have tried several experiments with different substances, applying them externally. In nearly all cases I had no expectation of success, but tried them owing to the belief in them held by practical men. In no case has there been any success, and it is more than improbable that there should be. The mycelium of the fungus permeates all the cells, the diseased tissue, and any substance applied which would kill the mycelium of the fungus, and must necessarily kill the tissues as well, and will most probably damage a larger area of bark than is attacked by the fungus. The knife does exactly the same work and in a more efficient manner, and even if a substance which could be trusted to destroy the parts affected were employed, it would be very much more expensive in Ceylon than the cost of labour. Two cases have come under my observation of estates where the canker appeared some two or three years ago, and the plantations have been kept practically free from canker by this method of cutting out, and there is no doubt that, if this had been carried out generally, that the loss by canker would have been inconsiderable.

With regard to the application of tar, it is in most cases absolutely harmful, as it acts as a waterproof over the diseased parts, keeps them damp, and the growth of the fungus goes on

beneath. It is also a mistake, as it conceals any bad work in cutting out when, for instance, no margin is left.

The above treatment, viz., cutting out all the diseased tissue, and also a good margin of healthy tissue beyond, in order to take away the outlying strands of mycelium, which are not present in sufficient quantity to discolor the bark, has in no case I have seen failed, and I have seen many hundreds of trees so treated ; but there are unfortunately many estates in which the trees have been so long diseased, and such a large area of the bark invaded by the mycelium of the fungus that it is impossible, without killing the tree, to entirely remove all the discoloured tissue. In such cases other treatment must be resorted to ; but it should clearly be understood that complete excision is the only sure method of curing the tree.

In cases where a large area on a tree is claret or neutral coloured, the treatment by shaving the cortex has been tried with varying success ; in one estate it has been practised for some three years, with almost invariable successful results.

A sharp pruning knife is the best instrument, though a spoke shave is very useful when the surface to be shaved is fairly even. All discolored parts should be exposed, and in addition, a margin of one and half to two inches should be also exposed round the discoloured part, leaving the claret or neutral portion in a frame of healthy bark. This is necessary, as has been already explained, because the mycelium spreads from the discoloured patch beyond, and unless it is in a certain quantity, gives no clue to its presence by any abnormal colour or moisture in the bark. All the shavings should be strictly collected and *burnt*, as they contain, in nearly every case, on the outside the spores of the fungus.

When this shaving is properly done, the exposure to the air (more especially with very thin shade) dries up the diseased tissue, and in some cases the dry and dead tissue scales out and drops away, while the remainder of the bark, being relieved from its enemy, forms a healthy callus round the injury, and in the course of time completely covers over the shaved part. This treatment has been tried on a good number of estates and only succeeds in a proportion of cases. I should estimate about 50 per cent. is certainly not too high. With the other 50 per cent., on examining the trees a week or ten days later, the mycelium, though greatly weakened in activity, is found to have spread gradually, and if this is again cut out, as a rule, the fungus is killed. In all cases where this second attempt, or, at any rate, the third, has been made to kill the fungus by exposure and without success, the best plan is to cut down and burn the tree, leaving, of course, a stump as far as possible for the production of "suckers."

The question of growing "suckers" in cacao is an extremely interesting one, apart from the question of the canker; but in regard to the canker, more important still. In my experiments I inoculated the stems of 30 healthy trees, and 26 of these acquired the canker, but in the case of "suckers," out of ten "suckers" so treated, I only procured the disease in one instance. The infrequency of canker on the suckers, compared with stem and branches even in badly diseased estates, is most noteworthy; and this is a most important recommendation in support of the practice of leaving the suckers, and not as is the usual practice, cutting them out wherever they appear. The whole question is perhaps more for the experience of the planter to deal with, but my observation leads me to doubt the advisability of the hard and fast rule to remove suckers from the tree without regard to the respective requirements of each plant; and in cases of estates where they were left, the health and cropping of the trees seem to me better. So that, when in addition to this we find that the suckers are less affected by the disease, it still further points to the desirability of at any rate trying the plan of allowing trees to produce suckers. One is told that suckers take a long time to produce fruit, but from observations taken, we find that fruit is borne on suckers very little more than a year old. In all cases where a tree is cut down to a stump, it is well to put in a supply plant, so that, should the suckers not form or not produce a good tree, time will not be wasted.

To sum up the measures which experiments have shown to be of value:—

1st. In all cases of cankered trees, to excise all diseased tissue, being careful to cut out all round beyond the discoloration.

2nd. Burn all diseased parts so removed.

The treatment by shaving only to be resorted to when the entire removal of the diseased tissue would be likely to prove fatal to a large number of the trees.

The best time for examining the trees is just after the rainy season, when the stems of the trees are dry. It is very difficult to detect any signs of the canker on the cortex when the trees are wet during rains, and the fungus which begins during the damp weather has not had time to produce a noticeable patch. In all estates there should be an inspection, and in places where the disease is unknown, it would be advisable that an intelligent cooly should be sent to an estate where the canker exists, in order to make himself familiar with its appearance; two or three days with the canker cutting coolies on any good estates, would enable an average cooly to

readily recognise it, and he would also learn the most workmanlike methods of cutting out, without doing more damage to the tree than is necessary.

If any doubt is felt with regard to a dark spot on a tree, a slight scratch with a knife will reveal the bark below either healthy or discolored.

There is another advantage attached to this cutting out of cankered spots which the planter will soon find out. The white borer originates, in the great proportion of cases, in the cankered places, the soft wet tissue there being more easily penetrated. On an estate, therefore, where cutting out the borers has had to be carried out pretty frequently, a great decrease will be found, when all the diseased patches are removed, and the same coolies who deal with the canker can easily add the cutting out of borers to their duties.

Since beginning to write this report I have had brought to my notice a canker on the thorny Bois tree—a tree extensively used for shade in cacao estates—(Erythrina umbrosa)—a canker, which on examination proved to be the cacao canker, and indeed experimentally proved by inducing the canker in cacao trees with inoculations of diseased tissue and spores from the Erythrina. There is no doubt, considering the infrequency of this disease on the Bois, even in estates where the majority of the cacao trees are cankered, that it has come from the cacao to the Erythrina, and not *vice versa*, but it behoves planters to look to their shade trees, and to treat them surgically as well as their cacao trees whenever they notice any signs in them suspected to be canker.

Though in the first instance these investigations were directed to the canker disease and its effects, another disease attracted my notice, and is of great importance to cacao growers as it affects the pods, and consequently damages the crop, in some cases to a very large extent.

This pod disease is very easily distinguished from the other enemies affecting the pods, viz., Helopeltis, borers squirrels, &c. It causes a browning of the husk, which, almost invariably, begins either at the stalk or point of the pod, and not in the middle, and is marked by a definite line. (Fig. 5.) On cutting the pod open, it is found not to be superficial like the brown or black marks caused by Helopeltis, but to spread through the entire thickness of the husk, and if it has been going on for a few days affecting and discolouring the seeds also. This disease is caused by the presence of the mycelium of a fungus in the soft tissues of the fruit, the fungus belongs to the same group as the Potato disease.

It produces its fruits or reproductive bodies in the furrows of the pod, where they can be seen as a white mould. On examination microscopically, they will be found to consist of spherical or egg-shaped bodies containing round spores.

Pods attacked by this fungus are completely destroyed in about ten days. An important fact to remember is, that once the pod is attacked by this fungus, the seeds never increase in size, all the nutrition being taken up by the quick-growing mycelium. It is, therefore, of no use to keep any diseased pod on a tree, as no ripening or enlargement of the seed takes place—only increase and spread of the fungus. Very strict measures should be taken on estates where this disease exists, and all pods affected should be taken off directly any sign of the disease is noticed, and *burnt*. By this means the number of spores is reduced, and if carried out for some time the evil should be lessened to a great extent. Of course, as in the canker, the wet season is the time when this fungus flourishes; in a dry season it is not often met with.

Before concluding this report, I must refer to the great assistance I have received in carrying out these investigations, without which it would have been almost impossible to have gained any of the knowledge which is recorded here. The information afforded by planters has been most valuable. Of the greatest use are records which are usually kept—the rainfall; the crops each month; the deaths due to disease; ravages of the insect enemies, &c., &c., all of which lead to an increased knowledge in helping cacao to a healthy life. Agriculturists at home might well take a leaf out of the Ceylon planters' book in regard to these matters.

My thanks are especially due to those planters whose estates I visited, and who, in all cases, added to the pleasure of my visits by their hospitality and kindness.

These investigations have, at times, presented to me disappointing difficulties, but have always been of the greatest interest to me, and with so much still to learn of the cultivation of cacao, and the battle with its various enemies, fungi, insects, &c., I leave my observations and experiments with regret, but still with the hope that Ceylon cacao planters will continue to gain knowledge as to their cultivation, so that they may grow cacao to greater perfection and with increased profit.

8th October, 1898. J. B. CARRUTHERS.

P. S.—These investigations are being carried on for a short time during the wet season now beginning—specially with regard to the relation of the canker to the pods, and an additional note containing the information gained will be published. The Figures illustrating the above report will, in order not to delay publication, be issued with the final note.—J. B. C.